2025 Wx Study - Gap Analysis Chart (5/31/2002)				Technology					Science	
	Performance	Capability	Challenges	Computing	Communication	Detector	Space System	Software	Scientific	Scientific
TECHNOLOGY REQUIREMENTS	Objective	Maturity	Investments	Technology Challenges	Technology Challenges	Technology Challenges	Technology Challenges	Engineering Challenges	Research Challenges	Infrastructure Challenges
		1-8	1-8	1-8	1-8	1-8	1-8	1-8	1-8	1-8
OBSERVING SYSTEM										
Command and Control										
Artificial Intelligence (event detection)	**Semi-autonomous control of 30 spacecraft**	6.5	6.5	6.5	5.5	N/A	6.5	6.5	6.5	
System-wide Distributed Intelligence	**Semi-autonomous control of 30 spacecraft**	3.5	6.5	6.5	5.5	N/A	5.5	6.5	6.5	
Dynamically Reconfigurable Mission	**Semi-autonomous control of 30 spacecraft**	7.0	6.5	6.5	5.5	N/A	6.5	6.5	6.5	
Spacecraft & Instrument Tasking	**Semi-autonomous control of 30 spacecraft**	4.0	4.0	3.0	5.0	N/A	4.5	3.5	3.0	
Coordinated Multi-Spacecraft Observing	**Semi-autonomous control of 30 spacecraft**	4.0	4.0	3.0	5.0	N/A	4.5	3.5	3.0	
Coordinated Space & Ground Observing	**Semi-autonomous control of 30 spacecraft**	4.0	4.0	3.0	5.0	N/A	4.5	3.5	3.0	
Mission / Situation Dependent Observing	**Semi-autonomous control of 30 spacecraft**	4.0	4.0	3.0	5.0	N/A	4.5	3.5	3.0	
Dynamic Asset Re-assignment / Optimization	**Semi-autonomous control of 30 spacecraft**	4.0	4.0	3.0	5.0	N/A	4.5	3.5	3.0	
Communication, External Interfaces	**No Gap**									
Via Terrestrial Backbone Network Infrastructure	**No Gap**									
M/DAS	**No Gap**									
"Guiding Intelligence"	**No Gap**									
Computing	**No Gap**									
Observing System Network										
Communication, Internal		4.5								
Real-time Global Communication and Data Exchange		4.5								
RF Bandwidth		4.5								
Space System Architecture		4.5								
Seamless Space Ground Communications		4.5								
Internet in Space		4.5								
Protocol Development		4.5								
Data Security & Encryption		4.5								
Laser Communication (Space to Space)		4.5								
Forward Model										
Ground-based computing		2	2	1	NA	NA	NA	1	2	2
On-board computing		3	3	3	3	NA	2	3	2	3
Space-Based and In-Situ Observations										
Space-based Precipitation (Active)	**Global 1-hr @ 1km resolution**	4.5	4.5	2	2	3	6	3	4.5	4.5
Multi-frequency/polarized Precipitation & Cloud Radar		5.5		2	N/A	3				
Multple Phased-Array Antennae Technology		4.5		2	N/A	3	6			
Large Deployable Antennae	**1 km driver**	6		2	N/A	N/A	6			
On-board Power Generation (RF)		3		2	N/A	N/A	3			
Pointing Control Requirements				2	N/A	N/A	3			
On-board Processing				2	N/A	N/A				
Space-based Laser Winds (Active)		6	7	2	N/A		6	N/A		
Telescopy (heterodyne vs		5.5		2	N/A		6	N/A		
On-board Power Generation (Laser & SC control)	**minimum: 4kw avg, 7kw peak**	Schnurr		2	N/A		6	N/A		
UV Laser Technology & Techniques				2	N/A		6	N/A		
IR Laser Technology & Techniques				2	N/A		6	N/A		
Frequency Agile Receivers transmitters				2			6			
On-board Processing				2	N/A		N/A	N/A		
Space-based Soil Moisture	**Global 1-hr at 1 km horiz. resolution**	6.5	5							
Active										
Passive										
Hyperspectral Sensing (Passive)	IR Vertical Profiles vs. Land Characterization	2.5	5							
Detector Technology										
On-board Processing										
On-board Data Storage										

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		1-8	1-8	1-8	1-8	1-8	1-8	1-8	1-8	1-8
Space-based 3D Temperature & Humidity	**Global 3-hr @ .25 km vert. & 25 km horiz. res.**	3	5							
Interferometric Sounding Methods		4	4.5							
GPS Refraction / Limb Occultation Methods		3.5	5.5							
Differential Absorption LIDAR for humidity									2	4
Raman LIDAR for Pressure and Chemical Contituents										
Surface Ocean Winds	**Global 3-hr winds @ 25km vertical resolution**	1	4					2		
GPS Reflection		6	4.5						5.5	4
Scatterometry		1.5	4						2.5	
MW Polarimetry		3								
Conventional Terrestrial-based Observations		2	4							
Surface Shelter Observations (T,P,V,Q,C,R)		1	2	1	2	1		1	1	2
Aircraft (T,Q,V)		2.5	4	1	2	4		1		
Radiosondes (T,Q,V)		1	2	1	2	2		1	2	2
Automated Remote Release		2.5	4							
Unmanned Aerial Vehicles		5	4	3	3	N/A	N/A	3	N/A	N/A
EXPANSIONS										
Guidence, Navigation, and Control		6.5	4.5	5	4	4	6.5	6.5		
Pointing, Stabilization, Tracking Control, and geolocation performance	sub-mas knowledge, mas ctrl	6	4	5			6	4		
Low Cost/Power GPS time, position, attitude determin.	high=allt, < $50k, < 5 W	6	4	6			7	7		
"Drag-Free Orbit Control System Technology	sub-meter accuracy	5	4	1			4	1		
Innovative Multi-Function S/C Systems	highly integrated bus	5	5	4	4	4	5	3		
Spacecraft Autonomous Orbit Maintenance	30 S/C Management, no operator in loop	6	4	3	5		4	4		
On-Board Computing and Storage		6.5	6.5	6	6.5	N/A	5.5	6.5	6.5	
Image Processing & Analysis				6	6.5	N/A	5.5	6.5		
Data Processing & Analysis		6.5	6.5	6	6.5	N/A	5.5	6.5	6.5	
Processor Speed and Capacity		3	3	3	6	N/A	3	3	3	
On-board Data Storage		3	3	3	3	N/A	3	3	3	
Radiation Hardening		3	3	3	4	N/A	5.5	3	3	
Distributed, Dynamically Allocable Computing		6	6	5	5.5	N/A	5.5	6	5	
Reconfigurable, Mission-Dependent Software (FPGA)		6	6	5	5.5	N/A	5.5	6	5	
Artificial Intelligence Overhead		6	4	3	5	N/A	4	4	5	
Computing (High Performance)										
Data Storage & Archival	1.0 e+15 Bytes/day	3	3	3	3	N/A	N/A	4	4	
System Architectures & Data Systems		6	6	6	6	N/A	N/A	5	5	
Processing Capacity	1.0 e+10 GFLOPS	7	7	7	5	N/A	N/A	6	6	
MODEL & DATA ASSIMILATION SYSTEM										
Data Ingest and Preprocessing	Ingest and Pre-processing of >> 1 Tbyte / day	1	3	2	2	N/A	N/A	2	N/A	N/A
Data Aggregation and Reduction		1	3	2	2	N/A	N/A	2	N/A	N/A
Communication		1	4	2	N/A	N/A	N/A	2	N/A	N/A
Artificial Intelligence		1	3 - 4	2	N/A	N/A	N/A	3 - 4	3	N/A
Computing Capacity		2	1 - 2	3	N/A	N/A	N/A	3	N/A	N/A
Quality Control Function		1	1	1	N/A	N/A	N/A	1	2	2
QC Methodologies		1	1	1	N/A	N/A	N/A	1	2	2
Computing Speed & Capacity		1	1	1	N/A	N/A	N/A	1	2	1
Analysis and Assimilation Function	**Hourly analysis of 1.0 e+8 obs on 25 km grid**	7	5	6 - 7	N/A	N/A	N/A	2	4	4
4DVAR Methodologies		3	5	6	N/A	N/A	N/A	2	4	4
Kalman Filtering Methodologies		6 - 7	5	7	N/A	N/A	N/A	2	4	4

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Computing Speed & Capacity		7 - 8	7	7	N/A	N/A	N/A	5 - 6	4	4
Targeted Observation Methodologies		5.5	3	3	N/A	N/A	N/A	3	4	4
Error Growth Estimation / Prediction		5.5	3	3	N/A	N/A	N/A	3	4	4
Stichastic / Ensemble Predictions		5.5	3	3	N/A	N/A	N/A	3	4	4
Computing Speed & Capacity		7	7	7	N/A	N/A	N/A	3	4	4
Global Mesoscale Model	**1-10km Resolution Global Atmospheric Model**	7	6	4	N/A	N/A	N/A	4	6 - 7	5
Numerical Solutions & Techniques		5 - 6	5	3	N/A	N/A	N/A	3	5	4
Adaptive Grid Techniques		5 - 6	5	4	N/A	N/A	N/A	5	5	4
Targeted Observation Methodologies		4	5 - 6		N/A	N/A	N/A	4	5	4
Parameterization Development		6 - 7	6 - 7	5	N/A	N/A	N/A	4	5 - 6	4
Computing Speed and Capacity		3	3	3	N/A	N/A	N/A	4	N/A	N/A
SCIENCE INFRASTRUCTURE		4		2	N/A	N/A	N/A	2	2	2
Observing System Simulation Testbed		4		2	N/A	N/A	N/A	2	2	2